The Development of Cloud Scheme for GRAPES Global Model in China

Ma ZhanShan Liu Qijun

National Meteorological Center of China Meteorological Administration, Beijing ,China

A global medium range numerical weather prediction system, GRAPES, has been established in China. Clouds forecasting was one of the weakest aspects of all performance of the model system. It is an urgent problem to be resolved, because clouds play an important role in the prediction of dynamics, radiative, hydrological processes, as well as quantitative precipitation.

Efforts have been made to develop a new cloud scheme and incorporate it into the GRAPES Global Model in recent years (Fig.1). The cloud parameterization scheme includes three basic considerations: (1) A new double moment cloud microphysical scheme with some improvements in the representation of microphysical processes is included, which is suitable for global large-scale weather model; (2) A large-scale macro cloud approach proposed by Sundqvist (1978) and Sundqvist et al. (1989) contains an explicit calculation of cloud water /ice content involving the formation and evaporation of clouds and precipitation when vapor is not saturated for grid-box averaged vapor with 50 kilometers resolution model; (3) A sub-grid cloud parameterization processes based on Tiedtke (1989) use detrained condensate from SAS convective scheme as a source for grid-scale cloud water/ ice budget equations. (4) The mixing ratios and number concentrations of cloud, ice, snow, graupel and rain are prognostic variables in this double moment microphysical scheme.

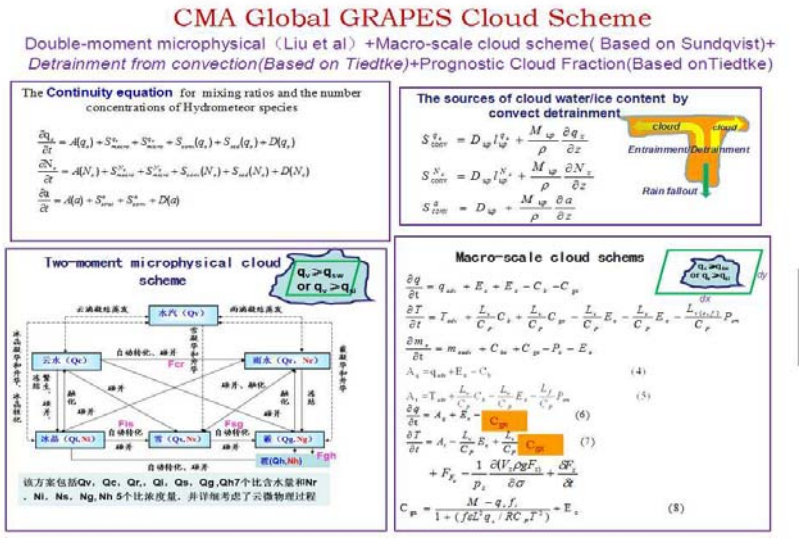

Fig. 1. The new global GRAPES model cloud scheme

Compared with CERES and MODIS satellite data and YOTC data, many aspects of the GRAPES model are systematically improved with this new cloud scheme, including the global

distribution of clouds and precipitation, particularly over the tropical regions, and the impact of cloud and precipitation on radiation. The detrainment from sub-grid convective and macro cloud process has a significant influence on the cloud fraction, liquid and ice water in both the tropics and mid-latitudes. Fig.2-Fig.3 shows the observation and forecast distributions of all hydrometeors at 400hPa and ice water path for July 2009, respectively.

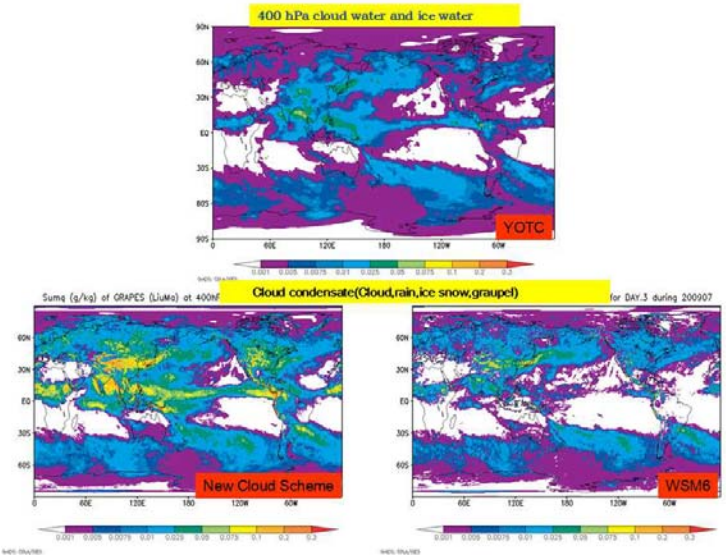

Fig.2 Distributions of all hydrometeors (g/kg) at 400hPa for July 2009

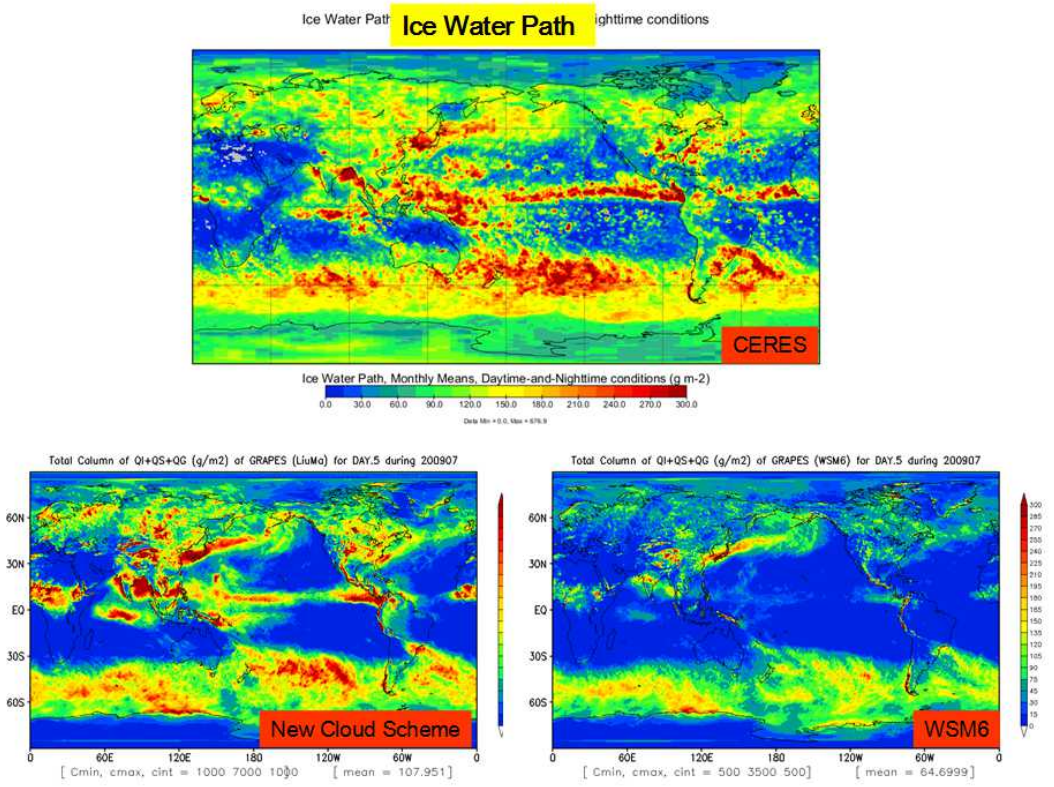

Fig.3 Distributions of Ice water path (g/m^2) at 400hPa for July 2009

Summary

(1) NMC of CMA has been developing GRAPES Cloud Scheme. The cloud scheme includes double-moment microphysical, macro-scale cloud scheme, detrainment from convection and prognostic cloud fraction.

(2) Using NMC Cloud Scheme, significant improvements in cloud and precipitation forecasting was made, especially in tropical area. Generally, the cloud fields prediction of NMC cloud scheme is consistent with satellite cloud data and YOTC.

(3) Cloud and quantitative precipitation forecasting has been one of the weakest aspects of NWP model. The treatment of “How to balance” between grid-scale cloud scheme and sub-grid convective is still a key problem for GRAPES global model with the 50 km resolution.